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ABSTRACT

Kindergarten through third grade children's responses to concrete and verbal class-inclusion problems were compared under several presentation formats. Children initially had more difficulty with the verbal task which was highly specific in format than with the concrete tasks. These differences, however, were easily eliminated by an extensive probing procedure and children were able to make the same level of responses under both media of presentation. Verbal problems which were non-specific in format were significantly more difficult than highly specific verbal or concrete problems. The findings support the competence-performance distinction for class-inclusion reasoning under different presentation formats. (Author/MS)

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Class-Inclusion: An Analysis of Responses Under Concrete and Verbal Presentation[1]

Session #1402

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Kindergarten through third grade children's responses to concrete and verbal class-inclusion problems were compared under several presentation formats. Children initially had more difficulty with the verbal task which was highly specific in format than with the concrete tasks. These differences, however, were easily eliminated by an extensive probing procedure and children were able to make the same level of responses under both media of presentation. Verbal problems which were non-specific in format were significantly more difficult than highly specific verbal or concrete problems. The findings support the competence-performance distinction for class-inclusion reasoning under different presentation formats.

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Responses to verbally and concretely presented class-inclusion problems have been compared in a number of studies, but no consistent results have been obtained. The standard, concrete class-inclusion problem developed by Piaget (1950) as a test of logical classification, involves presenting the child with two sets of objects, unequal in number, which belong to one superordinate class (e.g., 7 blue and 3 yellow wooden beads). The child is asked to compare the extensions of the superordinate and the larger subclass ("Are there more wooden beads or more blue beads?"). Prior to logical classification, the child compares the two subclasses rather than the subclass and the whole. Piaget has proposed that the development of logical responses to verbally presented problems may lag as much as two years behind logical responses to concretely presented ones. Although some research evidence supports this judgment (Jennings, 1970; Schwartz, 1970), other evidence suggests that the two media of presentation are of equal difficulty (Brainerd & Kaszor, 1974) or that for young children the verbal medium is easier than the concrete one (Wohlwill, 1968).

Procedural differences and a variety of problem formats both within and across studies may be sources of the conflicting results. One critical difference is that Jennings (1970), Piaget (1950), and Schwartz (1970) used the children's justifications in scoring the results whereas Wohlwill (1968) and Brainerd & Kaszor (1974) did not. Jennings (1970) noted that in response to the verbal problems, a number of subjects made inadequate justifications by including additional subclasses in the superordinate. For example, for the problem, "Suppose I have 7 dogs and 3 horses, do I have more animals or more dogs?" some children justified a "More animals" response by stating, "Cuz there's cows, pigs, sheep. . ." Since this extension of the superordinate class would be unlikely under concrete presentation, failure to take into consideration the child's justification might inflate

scores on the verbal problems compared to the concrete ones.

Another critical difference lies in the presentation format of the concrete and verbal problems. Piaget's verbally presented problem was of the type, "In all the woods are there more flowers or more primulas?" This format differed from his standard, concrete one in that (a) an indefinite number of subclasses was involved, (b) the complementary subclasses were not identified by name and (c) there was no indication of the numerosity of the subclasses. The general lack of specificity makes this format potentially more difficult than the concrete one. In the other studies cited above, the format for the verbal problems was more specific, with two subclasses named and enumerated. However, the formats for the concrete problems in some studies (Schwartz, 1970; Wohlwill, 1968) differed from the verbal ones in that the subclasses were not enumerated and the label for the complementary subclass was not given within the context of the class-inclusion problem (prior labeling may have occurred). For example, a picture containing six roses and two violets would be presented and the class-inclusion question asked, "Are there more flowers or more roses in this picture?" (Wohlwill, 1968). The dominant incorrect response to the problem is to identify the complementary subclass with the superordinate class. Failure to provide the complementary subclass label might facilitate this process. Some support for this hypothesis is given in a study by Winer (1973, cited by Brainerd & Kaszor, 1974). Performance on concrete class-inclusion problems was better when the subclasses were enumerated (and by implication labeled) than when they were not both labeled and enumerated. Since the cardinality of the two subclasses is given indirectly (i.e., visually) in the presentation of the concrete problem, it is hypothesized that the critical difference lies in the labeling of the

complementary subclass.

The possibility that the relative difficulty of the concrete and verbal problems can be altered by changes in the presentation format, suggests the need to draw a distinction between competence and performance. Piaget's theory (1950, Inhelder & Piaget, 1964) implies that the same operational structures (competence) would be required for solution of the verbal and concrete class-inclusion problems, i e., the logical, reversible addition of classes. Yet, Piaget (1950) states that the performance on the verbal task lags behind performance on the concrete one. According to the competence-performance model of Flavell & Wohlwill (1969), performance differences of a given child on tasks requiring the same cognitive competence may be accounted for by different information processing demands of the tasks and the skills of the child relative to those demands. The information processing demands of a particular type of cognitive task (e.g., the class-inclusion problem) might vary as a function of a number of factors:

> . . .the stimulus materials and their familiarity, the manner of presentation of the relevant information to be abstracted, the sheer magnitude of the information load placed on the child in dealing with the problem, the role played by memory and sequential processing of information, and so on (p. 99).

Differences across and within the studies cited above in the labeling and/or enumeration of both subclasses in the concrete tasks and in the specificity of the subclasses in terms of number, type and numerosity in the verbal tasks might have created or altered differences in the information processing demands of the tasks. This could have disguised actual differences or suggested differences not there. These hypotheses were tested by the selection of particular verbal and concrete presentation for-

mats for investigation. Even under identical presentation formats, the concrete and verbal class-inclusion problems might require different competence and/or information processing skills relating to media of presentation. To test the hypothesis that the tasks require the same competence (operational classification), an extensive probing procedure (described below) was used to minimize any potential differences in information processing demands as a function of media of presentation. Any differences which remained between verbal and concrete tasks of identical format would, theoretically, more likely be attributable to different competence rather than information processing demands. No direct test was made of the hypothesis that assessment of performance on the verbal tasks would vary according to whether the child's explanation was used in scoring the results. Rather, it was decided to use the explanations in scoring the results under all conditions.

Subjects

A total of seventy children, in kindergarten through third grade of an elementary school in a small midwestern city, served as subjects in the study. Approximately seventy percent of the children were from middle-class SES backgrounds, the rest from lower-class SES backgrounds. Approximately twenty-five percent of the children were non-white, predominately black. The SES and ethnic composition was consistent across grade levels. The number of subjects and mean age at each grade level were as follows: kindergarten, N = 17, age = 6:1; grade I, N = 16, age = 7:2; grade II, N = 19, age = 8:1; grade III, N = 18, age = 9:3.

Tasks and materials

Four types of class-inclusion tasks involving species of farm animals (horses, cows, pigs, and sheep) were designed for use in the study. The species combinations used in the descriptions below are presented as

examples of each task.

1. Concrete-enumeration (CE): The experimenter presented the child with a 28" x 11" card containing one row of 7 animals of one type and another row of 3 animals of another type and stated: "Here are 7 (or 3) sheep and 3 (or 7) pigs. Are there more animals or more sheep (or, more sheep or more animals) in this picture?"
2. Concrete-no enumeration (CN): This task was identical to CE above with the exception that the experimenter stated: "Here are some horses and some cows" before asking the class inclusion question.
3. Verbal-enumeration (VE): The experimenter stated: "On a certain farm there are 7 (or 3) cows and 3 (or 7) pigs. Are there more animals or more cows (or, more cows or more animals) on that farm?"
4. Verbal-no enumeration (VN): The experimenter asked: "In all the world are there more animals or more pigs (or, more pigs or more animals)?"

Procedure

Twelve problems were designed for various animal combinations. A systematized, randomization procedure was used to assign three problems to each task for each subject, balancing species combinations and format features (the relative order of the larger and smaller subclasses and whether the world "animals" or the subclass name came first in the question) across the verbal and concrete tasks. Each subject was individually tested by a female graduate student on all twelve problems in one of two orders: (a) VE, CN, VN, CE; (b) CN, VE, CE, VN. All three problems for each task were administered consecutively. Half of the children at each grade level were randomly assigned to each order. Since there were insufficient numbers of children at each grade level to test for all possible order effects, the two orders above were designed to provide, theoretically, the least facilitation or interference from one type of task to another. By using two orders, task and order would not be confounded and a general test of order effects would be possible.

The individual sessions, which lasted approximately twenty minutes,

were tape-recorded and transcribed for analysis. During the preliminary phase of the procedure the child was shown a picture containing a horse, a cow, a pig, and a sheep. The experimenter pointed to each animal and asked the child to identify it. All the children could do this easily. The experimenter then asked the child, "What are all of these?" If the child did not respond, "animals," the experimenter asked, "I have a picture here of four. . .what?" Every child responded "animals" to either the first or the second question. The twelve problems assigned to the child were then administered under Order A or B, described above.

After the child responded to a problem, the experimenter asked, "Why is that?" If the child did not give the correct response accompanied by an appropriate justification (e.g., "Horses are animals, too," "There's 10 animals and only 7 horses."), the following probing procedure was instigated: (1) the question was repeated under the following format: "I didn't ask whether there were more horses or more cows, but whether there were more horses or more animals."; (2) questions were asked focusing on whether both subclasses were animals (e.g., "Are horses animals too?") and the class-inclusiong question was repeated; (3) the child's response was challenged by such questions as, "If horses are animals too, why do you say there are only three animals?" The class-inclusion question was then repeated. If the child gave a correct response and adequately justified it during any of the above stages, the probing stopped for that problem.

The above procedure was not appropriate for the Verbal-no enumeration problem ("In all the world. . ."). The pre-operational response of comparing subclasses resulted in the judgment that there were more animals since there were more <u>other</u> animals. When the child made this response, the experimenter asked if there would be more animals than horses, for example,

even if there was only one other kind of animal, e.g., pigs. Incorrect responses to this were then followed by the standard probing procedure. A number of children had difficulty making any response to this task. In general, the probing on this task was less systematic than on the other three tasks.

Results and Discussion

Only the child's initial response to each question was used in scoring the results. Responses were scored 2 if they were correct and appropriately justified (see above) and 1 if they were not. One exception to the scoring of the initial response was when the child responded to the Verbal-enumeration problem by extending the superordinate, e.g., "Because there's lots of animals on farms." In this case the experimenter said, "But on this farm there are only 3 sheep and 7 cows, nothing else." and then repeated the class-inclusion question. The child's response at this point was used in the analysis. A random sample of 10 transcripts were used to establish interrater reliability. Two raters agreed on 93% of the 120 problems involved.

The scores of the three problems for each task were summed to give the child a total score for each task. A 4 (Grade) by 2 (Order) by 4 (Task, repeated measure) analysis of variance was conducted. Significant main effects were found for Grade and Task and a significant interaction effect was found for Task by Order. The significant results of the analysis of variance are summarized in Table 1.

Insert Table 1 about here

Planned comparisons between means for adjacent grades revealed no significant differences. The means for each grade, K to 3rd respectively, (3.95, 4.46, 4.97, 5.36) show a steady, gradual increase from one grade level

to the next. Possible mean scores ranged from 3 to 6. No comparisons were conducted for the Task main effect since the Task by Order interaction was significant. That interaction is plotted in Figure 1 below.

Insert Figure 1 about here

An analysis of the Task by Order interaction reveals that differences within Order between the Verbal-enumeration and the Concrete-no enumeration tasks were a function of relative order. Tests of differences between means revealed that when both tasks were either first in order or both were second, there were no significant differences between them. For the order in which each task came second, neither differed signifiantly from the Concrete-enumeration task for that order. Since there were no differences under order A between the two concrete tasks, the hypothesis that labeling of the complementary subclass rather than enumeration was a critical factor in previous studies was given some support. However, specific testing of labeling versus no-labeling is required as well as testing of the enumeration hypothesis without the potential confounding from the probing procedure used in this study.

Responses to the Verbal-no enumeration task ("In all the world. . .") under both orders combined were significantly lower than those to any of the other three tasks ($p < .001$). This finding supports the hypothesis that the lack of specificity of this format requires a higher level of cognitive functioning. An alternative hypothesis is that the lower scores reflect the weakness of the probing procedure for this task.

Although no significant differences were found between the concrete tasks and the Verbal-enumeration task when the effects of Order were controlled, there is evidence of initial differences which were eliminated by the effects of the extensive probing procedure. An examination of subjects'

responses to the first problem presented to them reveals that those who received the VE problem first had much more difficulty than those who received the CN problem first. However, by the second or third problem in the set, the differences disappeared. The percentages of subjects in each order responding correctly to each of the twelve problems are given in Table 2.

Insert Table 2 about here

The facilitating effects of the probing procedure are evident for both types of problems, but they were stronger for the verbal than for the concrete. Responses to the VE task were significantly higher under Order B when it came second than under Order A when it came first ($p < .01$). There were no significant differences between responses to the CN task under Orders A and B ($p > .10$). For Order A, responses increased significantly from the first (VE) to the second (CN) task ($p < .01$). This effect was weaker under Order B when the concrete task came first and the verbal second ($p < .10$). These findings are attributed to the greater initial difficulty of the verbal problem, and the effect of the probing procedure in bringing the responses to the two types of tasks to the same level. This provides support for the hypothesis that verbal and concrete class-inclusion problems with the same format require the same cognitive structures for solution but different, information processing skills. The information processing demands, however, appear to be easily modifiable, especially for the verbal task.

The effectiveness of the probing procedure in this study makes direct comparisons with the previous studies difficult. The failure to find any differences between the concrete enumeration and no-enumeration tasks may be attributed to the hypothesis that labeling of the complementary subclass

rather than enumeration is the critical factor, or to the effectiveness of the probing procedure in eliminating potential differences. While questions relating to the differential difficulty of presentation formats still remain, the effectiveness of the probing procedure illustrates the susceptibility of performance on the class-inclusion task to environmental manipulation. It is hypothesized that media of presentation determines, in part, the information processing demands of the task but not the competence demands. On the other hand, differences in levels of responding between the specific and non-specific formats, differences which were not eliminated by the probing procedure, may be a function of differential competence demands.

The results suggest the need for the child to be given specific information either verbally or concretely when he is asked to make logical judgments. When concrete supports are not available, the child may require assistance in processing the information in an appropriate way. Further research is needed to identify the nature of the initial difficulties found in this study for verbally presented class-inclusion problems, and the reasons for the effectiveness of the probing procedure. Specifically, we need to know in what ways differences in presentation format, including media of presentation, affect the information processing demands of the class-inclusion task.

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Table 1

Analysis of Variance--Summary of Significant Results

Source	SS	df	MS	F	P
grade	78.82	3	26.27	10.36	.0001
error	157.20	62	2.54		
task	41.96	3	13.99	25.79	.0001
task x order	9.05	3	3.02	5.56	.001
error	100.87	186	.54		

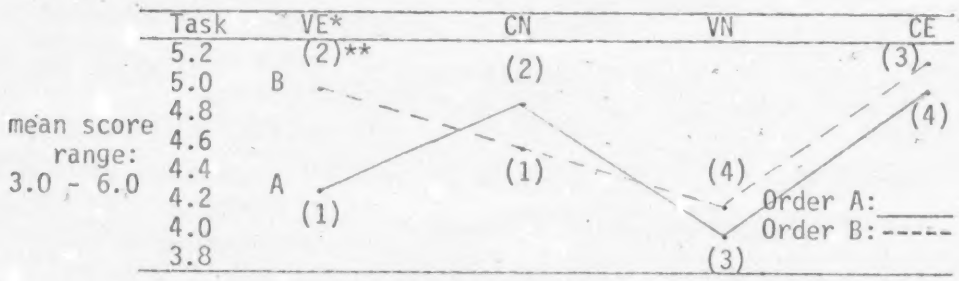

Figure 1
Task x Order Interaction
Mean Scores for each Task for each Presentation Order

*VE: Verbal-enumeration; CN: Concrete-no enumeration;
VN: Verbal-no enumeration; CE: Concrete-enumeration

**(Relative sequence of task presentation in parentheses)

Table 2

Percentages of Subjects Giving Correct and Appropriately Justified Responses to each Problem According to Order of Presentation

Order A	VE1	VE2	VE3	CN1	CN2	CN3	VN1	VN2	VN3	CE1	CE2	CE3	
	9	57	66	51	69	74	34	31	34	66	74	74	N = 35
Order B	**CN1**	**CN2**	**CN3**	**VE1**	**VE2**	**VE3**	**CE1**	**CE2**	**CE3**	**VN1**	**VN2**	**VN3**	
	31	66	69	63	71	77	71	80	77	31	40	57	N = 35